THE INSTITUTE FOR

INTERCONNECTING

AND PACKAGING

ELECTRONIC CIRCUITS

IPC-7721 Change 1 Pages March 2000

Repair and Modification of Printed Boards and Electronic Assemblies

Developed by the Printed Board Repair Task Group (7-34a) of the Institute for Interconnecting and Packaging Electronic Circuits

Users of this standard are encouraged to participate in the development of future revisions.

Contact:

IPC
2215 Sanders Road
Northbrook, Illinois
60062-6135
Tel 847 509.9700
Fax 847 509.9798

Acknowledgment

Any Standard involving a complex technology draws material from a vast number of sources. While the principal members of the IPC Printed Board Repair Task Group (7-34a) of the Product Assurance Committee are shown below, it is not possible to include all of those who assisted in the evolution of this standard. To each of them, the members of the IPC extend their gratitude.

Product Assurance Committee

Chairman
Mike Hill
Viasystems Technologies Corp.

Printed Board Repair Task Group

Chairman
Jeff Ferry
Circuit Technology Center, Inc.

Vice Chairman
Christine Miller
FORE Systems, Inc.

Technical Liaisons of the IPC Board of Directors

Stan Plzak
Pensar Corp.

Peter Bigelow
Beaver Brook Circuits Inc.

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Blakley, Peggi, NSWC Crane
Brock, Ron, NSWC Crane
Day, Jennifer, Soldering Technology International
Ferry, Jeff, Circuit Technology Center, Inc.
Foster, Daniel L., PACE Inc.
Hersey, Ralph J., Ralph Hersey & Associates
Hopkins, Reed, Metcal Inc.
Houghton, F.D. Bruce, Celestica Corporation
Miller, Christine A., FORE Systems Inc.
Moffitt, James H., Moffitt Consulting Services
Norton, John S., Tektronix Inc.
Siegel, Eric, PACE, Inc.

Printed Board Repair Task Group

Anderson, Kari, Hughes Technical Services Co.
Aoki, Masamitsu, Toshiba Chemical Corp.
Ashaolu, Peter, Cisco Systems Inc.
Bates, Timothy E., DSC Communications Corporation
Bergum, Erik J., Polyclad Laminates
Blakley, Peggi, NSWC Crane
Boerdner, Richard W., EJE Research
Bogert, G.L., Westinghouse Electric
Bradford, Diana, Soldering Technology International
Brock, Ron, NSWC Crane
Cash, Alan S., Northrop Grumman Corporation
Chance, Gary W., Nokia Telecommunications
Chen, D. Phillip, Honeywell Canada
Cirimele, Ray, Diversified Systems Inc.
D'Andrade, Derek, Surface Mount Technology Centre
Daugherty, Dale, Siemens Energy & Automation
Day, Jennifer, Soldering Technology International
Deane, William, Solectron Technology Inc.
Dehne, Rodney, O.E.M. Worldwide
Dennehy, Charles S., Circuit Technology Center Inc.
Dieffenbacher, William C., Lockheed Martin Corporation
DiFranza, Michele J., The Mitre Corp.
Dutcher, Nancy, U.S. Assemblies Hallstead Inc.
Etheridge, Thomas R., McDonnell Douglas Aerospace
Falconbury, Gary, Raytheon Technical Services Co.
Ferry, Jeff, Circuit Repair Corporation
Fieselman, Charles D., IBM Corp.
Foster, Daniel L., Pace Inc.
Foust, Skip, Solectron Technology Inc.
Freeman, Fortunata A., Solectron Technology Inc.
Gillespie, Alan L., Boeing/McDonnell A & MS
Gonzalez, Constantino, ACME, Inc.
Griffiths, William F., Plessey Tellumat South Africa
Grim, Edward A., Raytheon Systems Company
Hargreaves, Larry, DC. Scientific Inc.
Herrberg, Steven A., Hughes Defense Communications
Hersey, Ralph J., Ralph Hersey & Associates
Hiett, Carol E., Lockheed Martin Astronautics
Hill, Michael E., Viasystems Technologies Corp.
Ho, David P., Circuit Graphics Ltd.
Hopkins, Reed, Metcal Inc.
Houghton, F. D. Bruce, Celestica
Hymes, Les, Les Hymes Associates
Johnson, Kathryn L., Hexacon Electric Company
Johnson, Laurence G., General Electric Co.
Jones, Sue A., Compaq Computer Corporation
Kemp, Cindy A., Evenflo Company Inc.
Kennady, Richard, Bahiatech Bahia Technologia Ltda.
Kern, Terence, Axiom Electronics, Inc.
Konsowitz, Robert J., Glasteel Industrial Laminates
Korth, Connie M., Hibbing Electronics Corp.
Lambert, Leo P., EPTAC Corporation
Lee, Frederic W., Northrop Grumman Norden Systems
MacLennan, Karen E., M/A-COM Inc.
Maher, Peter E., Kimball Electronics Group

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Malewicz, Wesley R., Siemens Medical Systems Inc.

Mastorides, John, Lucas Aerospace Power Systems

May, William Dean, NSWC - Crane

McCormick, Becky, EMD Associates Inc.

Meeks, Jr., Stephen, Motorola Computer Group

Miller, Christine A., FORE Systems

Moffitt, James H., Moffitt Consulting Services

Moir, Jim, Hewlett Packard Co.

Neumark, Yori, Hadco Corp.

Nicol, David, Lucent Technologies Inc.

Northam, Riley L., EMPF/ACI

Norton, John S., Tektronix Inc.

Nunnelley, Benetta, IEC Electronics Corp.

Nuppola, Seppo, Nokia Networks, Switching Platform

Parrish, Mel, EMPF/ACI

Poelking, Monica, Defense Supply Center Columbus

Quinn, Paul J., Lockheed Martin Missiles & Space

Raby, Jim D., Soldering Technology International

Rassal, David, 3COM Corporation

Rausch, James E., Delphi Delco Electronics Systems

Raye, John F., Defense Supply Center Columbus

Robertson, David E., Hexacon Electric Company

Rowe, Teresa M., AAI Corporation

Sanford, Kelly, Micron Custom Mfg. Services Inc.

Scott, Patricia A., Electronic Training Advantage

Sherman, Lowell, Defense Supply Center Columbus DSCC

Siegel, Eric, PACE, Inc.

Smith, Rick B., Motorola Inc.

Sober, Douglas J., Polyclad Laminates Inc.

Steele, David B., Lucent Technologies Inc.

Steen, Wayne A., Rockwell International

Tevels, John R., Harris Corp.

Thompson, Ronald E., NSWC - Crane

Torres, Steven, Corlund Electronics Corp.

Ventress, Sharon T., U.S. Aviation & Missile Command

Woodford, James Walter, Department of Defense

Wooldridge, James R., Rockwell International

Xiao, Nora, Tektronix Inc.

Youngblood, Don, Honeywell Inc.

Foreword

IPC's documentation strategy is to provide distinct documents that focus on specific aspects of electronic packaging issues. In this regard document sets are used to provide the total information related to a particular electronic packaging topic. A document set is identified by a four digit number that ends in zero (0) (i.e., IPC-7710).

This standard is intended to provide information on the rework, repair and modification of printed boards and electronic assemblies. This information must also be supplemented by a performance specification that contains the requirements for the chosen technology. When used together, these documents should lead both manufacturer and customer to consistent terms of acceptability.

These documents supersede the following:

IPC-7711 supersedes IPC-R-700C
IPC-7721 supersedes IPC-R-700C

As technology changes, a performance specification will be updated, or new focus specifications will be added to the document set. The IPC invites input on the effectiveness of the documentation and encourages user response through completion of "Suggestions for Improvement" forms at the end of each document.

Conductor Repair

Procedure	Description	Illustration	Product Class	Skill Level	Level of Conformance
4.2.1A	Conductor Repair, Foil Jumper, Epoxy Method		R, F, C	Advanced	Medium
4.2.2	Conductor Repair, Foil Jumper, Film Adhesive Method		R, F, C	Advanced	High
4.2.3	Conductor Repair, Weld Method		R, F, C	Advanced	High
4.2.4	Conductor Repair, Surface Wire Method		R, F, C	Intermediate	Medium
4.2.5A	Conductor Repair Through Board Wire Method		R	Advanced	Medium
4.2.6	Conductor Repair/Modification, Conductive Ink Method		R, F, C	Expert	Medium
4.2.7	Conductor Repair, Inner Layer Method		R, F	Expert	High

Jumpers

Procedure	Description	Illustration	Product Class	Skill Level	Level of Conformance
6.1	Jumper Wires		R, F, W, C	Intermediate	N/A
6.2.1	Jumper Wires, BGA Components, Foil Jumper Method		R, F	Expert	Medium

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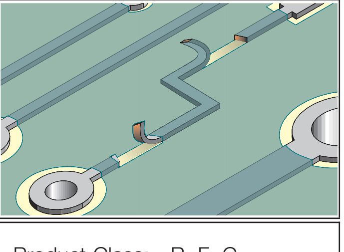
Repair and Modification of Printed Boards and Electronic Assemblies

Revision: **A**

Date: **11/99**

Number: **4.2.1**

Conductor Repair, Foil Jumper, Epoxy Method



Product Class: R, F, C

Skill Level: Advanced

Level of Conformance: Medium

OUTLINE

This method is used on printed wiring boards to replace damaged or missing conductors on the printed wiring board surface.

CAUTION

The conductor widths, spacing and current carrying capacity must not be reduced below allowable tolerances.

REFERENCES

2.1 Handling Electronic Assemblies
2.2 Cleaning
2.5 Baking and Preheating
2.6 Epoxy Mixing and Handling

TOOLS AND MATERIALS

Buffer
Cleaner
Conductor Foil Jumpers
Color Agent
Various Colors
Epoxy
Hand Held Drill
Heat Lamp
Polyimide Tape
Knife
Light
Liquid Flux
Microscope
Oven
Scraper
Solder
Solder Iron
with Tips
Wipes

PROCEDURE

1. Clean the area.
2. Remove the damaged section of conductor using a knife. The damaged conductor should be trimmed back to a point where the conductor still has a good bond to the printed wiring board surface.

   NOTE
   Heat can be applied to the damaged conductor using a soldering iron to allow the conductor to be removed more easily.
3. Use a knife and scrape off any solder resist or coating from the ends of the remaining conductor. (See Figure 1.)
4. Remove all loose material. Clean the area.

   NOTE
   It is essential that the board surface be smooth and flat. If the base material is damaged see appropriate procedure.

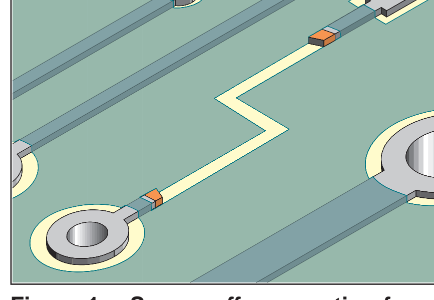


Figure 1 Scrape off any coating from the ends of the remaining conductors.

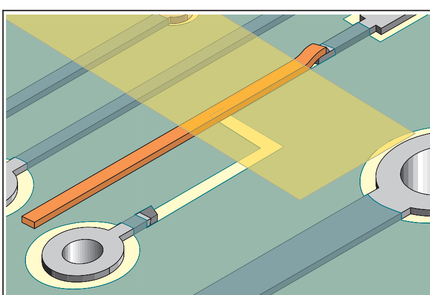


Figure 2 Place the new foil jumper in position, hold in place with tape conductor.

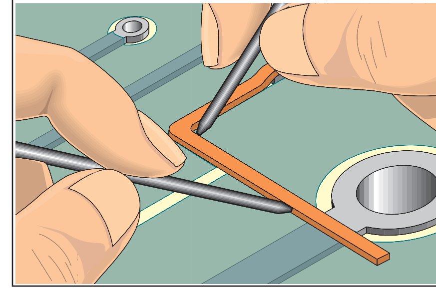


Figure 3 Bend foil jumper using 2 wood sticks.

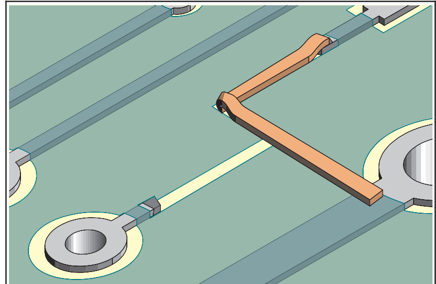


Figure 4 Wide conductors may be folded over.

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5. Apply a small amount of liquid flux to the ends of the remaining conductor. Tin the exposed end of each conductor using solder and a soldering iron.
6. Clean the area.
7. Select a conductor foil jumper to match the width and thickness of the conductor to be replaced. Cut a length approximately as needed. The foil jumper should overlap the existing conductor a minimum of 2 times the conductor width.

   NOTE

   The new conductor may be trimmed from copper sheet.
8. Gently abrade the top and bottom surface of the replacement foil jumper with a buffer to remove the protective coating.

   NOTE

   A thin protective coating is often applied to the replacement foil jumper to prevent oxidation.
9. Clean the conductor foil jumper.
10. If needed, the ends of the replacement conductor foil jumper may be tinned with solder prior to lap soldering it in place.
11. If the conductor foil jumper is long or has bends, one end may be soldered prior to forming the new shape. Place the foil jumper in position. The foil jumper should overlap the existing conductor a minimum of 2 times the conductor width. The jumper may be held in place with Polyimide tape. (See Figure 2.)
12. Apply a small amount of liquid flux to the overlap joint.
13. Lap solder the foil jumper to the conductor on the printed wiring board surface using solder and a soldering iron. Make sure the foil jumper is properly aligned.

    NOTE

    If the configuration permits, the overlap solder joint connection should be a minimum of 3.00 mm from the related termination. This gap will minimize the possibility of simultaneous reflow during soldering operations.
14. Bend the foil jumper as needed to match the shape of the missing conductor. (See Figure 3.)

    NOTE

    Two wood sticks can be used to make sharp bends in the replacement foil jumper. Use one stick to hold the new jumper at the bend location and use the other wood stick to form the shape as needed.
15. Wide conductors that cannot be easily formed may be folded over to produce a sharp bend. (See Figure 4.)
16. Form the final shape of the jumper and hold in place with tape. Lap solder the foil jumper to the remaining conductor on the printed wiring board surface using solder and a soldering iron. Remove the tape used to hold the foil jumper. Clean the area. (See Figure 5.)
17. Mix the epoxy. If desired, add color agent to the mixed epoxy to match the printed wiring board color.

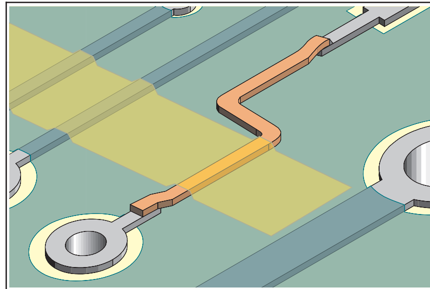

Figure 5 Form the final shape of the jumper and hold in place with tape.

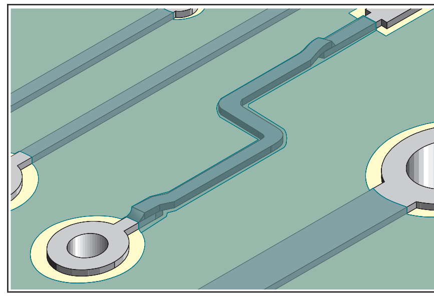

Figure 6 Coat the top and sides of the foil jumper with epoxy.

18. Coat the top and sides of the foil jumper with epoxy. The epoxy bonds the foil jumper to the printed wiring board surface and insulates it. A wooden stick sharpened at one end may be used to apply and spread the epoxy. (See Figure 6.)
19. Cure the epoxy per the manufacturers instructions.

    CAUTION

    Some components may be sensitive to high temperature.
20. Apply surface coating to match prior coating as required.

EVALUATION

1. Visual examination for alignment and overlap of foil jumper.
2. Visual examination of epoxy coating for texture and color match.
3. Electrical tests as applicable.

NOTES

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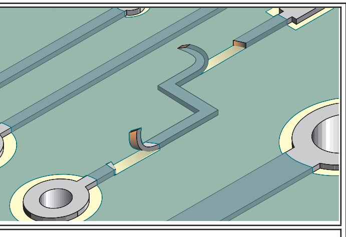
Repair and Modification of Printed Boards and Electronic Assemblies

Revision: A

Date: 11/99

Number: 4.2.5

Conductor Repair, Through Board Wire Method



Product Class: R
Skill Level: Advanced
Level of Conformance: Medium

OUTLINE

This method is used on printed wiring boards to replace damaged or missing conductors on the printed wiring board surface. A length of standard insulated or non-insulated wire is used to repair the damaged conductor.

CAUTION

The conductor widths, spacing and current carrying capacity must not be reduced below allowable tolerances.

CAUTION

This method is not acceptable when wire will be subsequently subjected to a mass soldering operation.

REFERENCES

2.1 Handling Electronic Assemblies
2.2 Cleaning
2.5 Baking and Preheating

TOOLS AND MATERIALS

Cleaner	Solder
Knife	Soldering Iron with Tips
Liquid Flux	Wipes
Dental Style Drill	Solid Wire
Microscope	

PROCEDURE

1. Clean the area.
2. Remove the damaged section of conductor using the knife. The damaged conductor should be trimmed back to a point where the conductor still has a good bond to the printed wiring board surface.

   NOTE
   Heat can be applied to the damaged conductor using a soldering iron to allow the conductor to be removed more easily.
3. Use a knife and scrape off any solder resist or coating from the ends of the remaining conductor. (See Figure 1.)
4. Remove all loose material. Clean the area.
5. Apply a small amount of liquid flux to the ends of the remaining conductor. Tin the exposed end of each conductor using solder and a soldering iron.

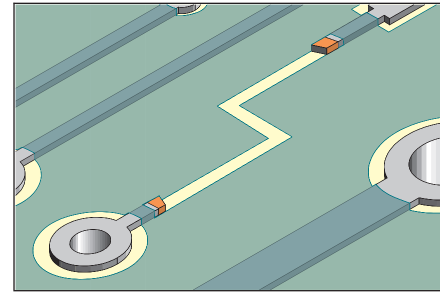


Figure 1 Scrape off any coating from ends of remaining conductors.

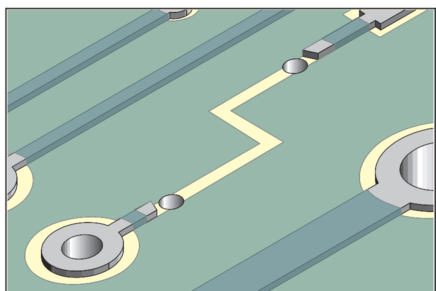


Figure 2 Drill through board adjacent to conductor.

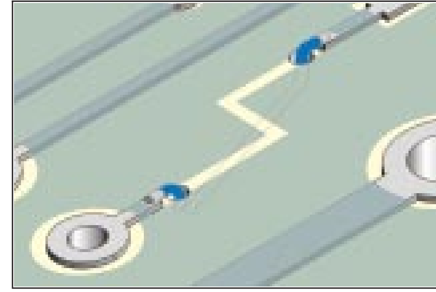


Figure 3 Drill through board, through conductors.

Figure 4 Lap solder wire to conductor.

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6. Clean the area.
7. Select a wire to match the width and thickness of the conductor to be replaced. Cut a length approximately as needed. See Table 1 for Solid Wire Equivalents.

Table 1 Solid Wire Equivalents

Conductor Width 2 oz. Copper	Equivalent Solid Wire Diameter
0.25 mm	#34, 0.15 mm
0.38 mm	#32, 0.20 mm
0.50 mm	#31, 0.23 mm
0.78 mm	#29, 0.28 mm
2.08 mm	#26, 0.46 mm
3.18 mm	#23, 0.58 mm
When using solid wire to repair a conductor, there should be no reduction in the cross sectional area.	

8. Strip the wire and tin the ends if needed. Non-insulated wire may be used for short repairs if conductors are not crossed.
9. Clean the wire.

   CAUTION

   Review conductor diagrams to be sure no surface or internal conductors will be damaged or shorted.
10. Drill through the board, either adjacent to both ends of the remaining conductors or through the conductors. Drill the hole slightly larger than the wire diameter to be used. (See Figure 2.)
11. Position the wire on the opposite side from the repair and insert the stripped ends into the drilled holes.
12. Bend the stripped wire over the prepared conductors in line with the conductors. The wire should overlap the existing conductor a minimum of 2 times the conductor width. (See Figure 3.)

    NOTE

    If the configuration permits, the overlap solder joint connection should be a minimum of 3.00 mm from the related termination. This gap will minimize the possibility of simultaneous reflow during soldering operations.
13. Apply a small amount of liquid flux to the overlap joint.
14 Lap solder the wire to the conductors on the printed wiring board surface. Make sure the wire is properly aligned. (See Figure 4.)
15. Form the wire on the opposite side to match the shape of the missing conductor.
16. Clean the area.

    NOTE

    It may be necessary to encapsulate the solder joint connection if electrical spacing is reduced.

17. If desired bond the wire to the printed wiring board surface with adhesive, epoxy or Tape Dots.

    CAUTION

    Some components may be sensitive to high temperature.

18. Cure the epoxy per Procedure 2.7 Epoxy Mixing and Handling.
19. After the epoxy has cured clean the area.

EVALUATION

1. Visual examination for alignment and overlap of wire.
2. Electrical tests as applicable.

NOTES

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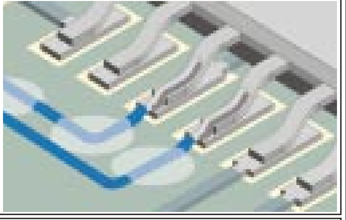
Repair and Modification of Printed Boards and Electronic Assemblies

Revision:

Date: **11/99**

Number: **6.1**

Jumper Wires



Product Class: R/F/W/C
Skill Level: Intermediate
Level of Conformance: N/A

OUTLINE

This procedure covers the repair/modification of printed boards and electronic assemblies by the use of jumper wires to complete electrical continuity between two points. This procedure is meant to provide a foundation for adding jumper wires during the repair/modification process. The techniques and guidelines are based on general commercial and industry practices.

Jumper wires fall into three (3) categories

1. Those that are considered wires and are installed during assembly. The routing, termination, and bonding of these jumper wires are documented by engineering instructions or drawing notations.
2. Those that are added after assembly to effect a change or modification. The routing, termination, and bonding of these jumper wires are documented by engineering change notice instructions or drawing notations.
3. Those that are added to correct a defect.

This procedure has nine main sections.

1. References
2. Tools and Materials
3. General Rules
4. PC Board Preparation
5. Jumper Wire Selection
6. Jumper Wire Preparation
7. Jumper Wire Termination and Routing
8. Jumper Wire Bonding
9. Jumper Wire Termination Figures

REFERENCES

1.0 Foreword
2.1 Handling Electronic Assemblies
2.2 Cleaning
2.5 Baking and Preheating

TOOLS & MATERIALS

Adhesive, Hot Melt
Adhesive, Quick Set
Cleaner
Cleaning Wipes
Flush Cutter
Flux, Liquid
Smooth Pliers
Solder
Soldering Iron with Tips
Tape Dots
Wire
Wire, Adhesive Coated
Wire Stripper

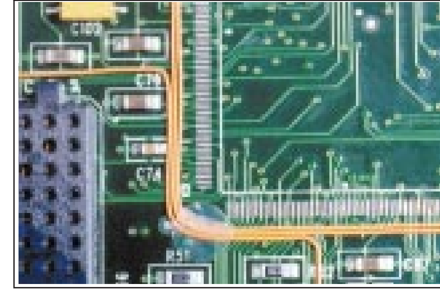


Figure 1 Route jumper wires.

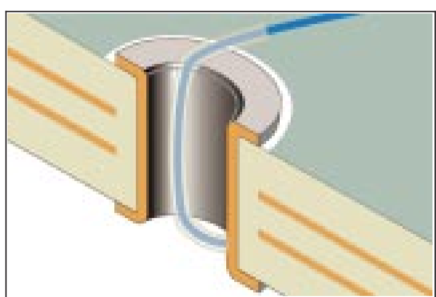


Figure 2 Use sleeving through PTH.

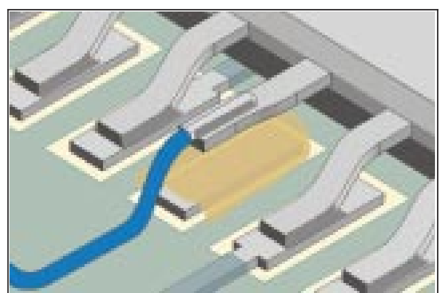


Figure 3 Use insulated wire if required.

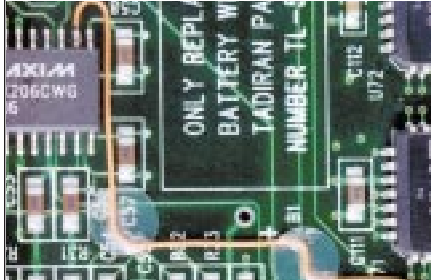


Figure 4 Bond wires using tape dots or strips.

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GENERAL RULES

1. Jumper wires should be placed on the component side of the assembly or printed board unless otherwise specified.
2. Jumper wires shall be routed in an XY manner as directly as feasible, making as few bends as possible. (See Figure 1.)
3. Jumper wires shall not be raised more than 3.2 mm [0.125 in] above the board surface or not above components or leads in such a way that they will interfere with PC board mounting.
4. Bare conductor jumper wires longer than 12.7 mm [0.50 in] shall not be used. Bare conductor jumper wires shorter than 12.7 mm [0.50 in] shall not violate the minimum electrical clearance.

   NOTE
   The 12.7 mm [0.50 in] dimension refers to the length between terminations.
5. Jumper wires may pass over lands provided sufficient slack is available so that the wire can be moved away from the land for component replacement. Jumper wires shall not pass over pads or vias used as test points.
6. Jumper wires shall not be routed under or over component leads or component bodies. Contact with heat sinks must be avoided.
7. Jumper wires shall not pass through component foot prints unless the layout of the assembly prohibits the routing in other areas.
8. Jumper wires shall have stress relief.
9. Jumper wires may be routed through plated through holes provided the wire is insulated and insulation sleeving is placed in the hole. If a hole is needed, use the following method. (See Figure 2.)

   A. Drill a hole 0.25 mm [0.010 in] larger than the insulation diameter.
   B. Inspect the hole for burs or exposed internal circuits.
   C. Document the added hole on a control drawing.

   NOTE
   Be careful that the drilled hole does not interfere with surface and internal conductors.
10. Jumper wires soldered into plated through holes must be discernible on the opposite side.
11. Jumper wires soldered to lifted or clipped component leads may require insulation to prevent shorting. (See Figure 3.)
12. Jumper wires may be terminated by a variety of methods. See illustrations.

PC BOARD PREPARATION

1. Clean the area.

   NOTE
   When wires are in place cleaning will often be more difficult.
2. Remove coating material or oxidization as necessary from the component leads, pads, or conductors where wire terminations will be soldered. Clean the area.

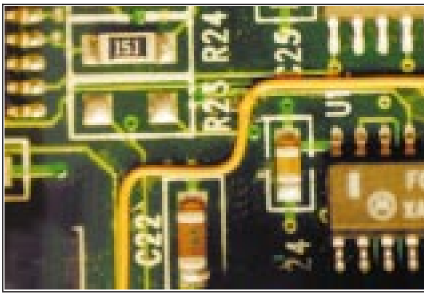

Figure 5 Bond wires using adhesive.

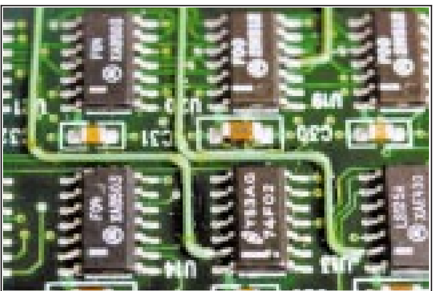

Figure 6 Adhesive coated wires are heat bonded.

3. Remove solder from the connection point if needed. Clean the area.
4. Measure approximately the length of each wire needed.

JUMPER WIRE SELECTION

1. Bare conductor jumper wires longer than 12.7 mm [0.50 in] shall not be used. Bare conductor jumper wires shorter than 12.7 mm [0.50 in] shall not violate the minimum electrical clearance.

   NOTE
   The 12.7 mm [0.50 in] dimension refers to the length between terminations.
2. Silver plated wire must not be used; under some conditions corrosion of the wire can occur.
3. The smallest diameter wire that will carry the required current should be selected.
4. Insulation requirements of the wire should withstand soldering temperatures, have some resistance to abrasion, have a dielectric resistance equal to or better than the board insulation material.
5. Recommended wire is solid insulated copper wire, tin lead plated, 22 to 32 AWG with Kynar, Milene, Kapton, Teflon or equivalent insulation.

   CAUTION
   Wires with nicked or damaged conductors should not be used.

JUMPER WIRE PREPARATION

1. Cut the jumper wires approximately 12.7 mm [0.50 in] longer than the estimated length needed.

   NOTE
   The length and gauge of the jumper wire may be critical. All wires have an electrical resistance (impedance) to the flow of electricity. This impedance is important to electronic circuitry. Always refer to wiring lists for specific jumper wire requirements.
2. Strip insulation from each end of the jumper wire.

   NOTE
   Strip length is dependent on the termination style.
3. If required, tin the stripped ends with solder. Clean if necessary.

JUMPER WIRE TERMINATING AND ROUTING

1. Form the wire as needed and place the wire in position depending on the termination style. Center the wire on the component lead or pad, do not overhang sides. If the wire is soldered to a pin, terminal or component lead, wrap the wire a minimum of 90°.
2. Solder one end of the wire. Clean if necessary.

   NOTE
   Solder joint length must meet acceptability requirements.

CAUTION
The insulation shall not be stripped back more than two wire diameters from the solder joint. Wire insulation may touch but not penetrate the solder joint provided proper wetting of the wire is evident.

3. Bend the wire as needed and run the wire along board surface. Route the jumper wire using the shortest route in an XY direction with the fewest possible bends to the second termination point.

NOTE
Jumper wires shall not be routed under or over component leads or component bodies. Contact with heat sinks must be avoided.

CAUTION
Do not bend the wire tighter than a radius of three times the conductor diameter.

4. After routing the jumper wire, solder the opposite end. Clean if necessary.

CAUTION
Wires soldered to lifted or clipped components leads may require insulation to prevent shorting.

JUMPER WIRE BONDING

1. After the wire has been soldered at both ends and cleaned if necessary, the wire should be bonded to the board surface.

NOTE
Bonding is not required if wire is insulated and insulated length is less than 25 mm [1.00 in].

2. Bond the jumper wire using one of the following methods.

   A. Tape Dots or Tape Strips. (See Figure 4.)
   B. Quick Set Adhesive. (See Figure 5.)
   C. Hot Melt Adhesive. (See Figure 5.)
   D. Hot Bonding. Some jumper wires are manufactured with a special thermo-set adhesive coating and are thermally bonded to the board surface with a special bonding tool. (See Figure 6.)

3. Bond the jumper wire within 6.0 mm [0.25 in] of each solder joint.
4. Bond the jumper wire within 6.0 mm [0.25 in] of each bend in the wire.
5. Bond the jumper wire at intervals not less than 25 mm [1.00 in] on straight runs.

Table 1 Jumper Wire Termination Methods

Figure	Type	Wire Termination Method	Acceptability
7	PTH Hole	Wire soldered into plated-through hole on component side. *	Acceptable
8	PTH Lead	Wire soldered parallel to lead on component side.	Acceptable
9	PTH Hole	Wire soldered into plated-through hole on solder side. *	Acceptable
10	PTH Hole	Wire wrapped around component lead on solder side.	Acceptable
11	PTH Hole	Wire wrapped around lead on component side.	Acceptable
12	PTH Lead	Wire soldered to lifted component lead. +	Acceptable
13	PTH Lead	Wire soldered to clipped lead on component side. +	Acceptable
14	PTH Lead	Wire looped and soldered to adjacent component leads.	Acceptable
15	PTH Lead	Wire soldered to lead, wire over component.	Not Recommended
16	PTH Lead	Soldered perpendicular to component lead.	Not Recommended
17	PTH Lead	Multiple wires soldered to component lead overhanging edge.	Not Recommended
18	Chip	Wire soldered to pad, parallel or perpendicular to component.	Acceptable
19	Chip	Wire soldered parallel or perpendicular to component.	Acceptable
20	Chip	Wire soldered to component end, lifted off pad.	Acceptable
21	Chip	Multiple wires overhanging pad edge.	Not Recommended
22	PTH Hole	Wire soldered into plated-through hole. *	Acceptable
23	PTH Pad	Wire soldered across top of PTH pad.	Acceptable
24	PTH Pad	Multiple wires soldered to pad overhanging pad edge.	Not Recommended
25	Conductor	Wire soldered parallel to conductor, contact, SMT pad.	Acceptable
26	Conductor	Wire perpendicular to conductor, contact, SMT pad.	Not Recommended
27	Conductor	Multiple wires soldered to conductor, contact, SMT pad.	Not Recommended
28	J Lead	Wire soldered parallel to component lead.	Acceptable
29	J Lead	Wire soldered to clipped component lead. +	Acceptable
30	J Lead	Wire looped and soldered to adjacent component leads.	Acceptable
31	J Lead	Wire soldered to component lead, wire running over component.	Not Recommended
32	J Lead	Wire soldered perpendicular to lead.	Not Recommended
33	J Lead	Multiple wires soldered to lead overhanging edge.	Not Recommended
34	J Lead	Wire soldered to lifted component lead.	Not Recommended
35	Gull Wing	Wire soldered parallel to component lead.	Acceptable
36	Gull Wing	Wire soldered to lifted component lead. +	Acceptable
37	Gull Wing	Wire soldered to clipped component lead. +	Acceptable
38	Gull Wing	Wire looped and soldered to adjacent component leads.	Acceptable
39	Gull Wing	Wire soldered to component lead, wire over component.	Not Recommended
40	Gull Wing	Wire soldered perpendicular to component lead.	Not Recommended
41	Gull Wing	Multiple wires soldered to lead overhanging edge.	Not Recommended

* Jumper wires soldered into plated-through holes must be discernible on the opposite side.
\+ Jumper wires soldered to lifted or clipped component leads may require insulation to prevent shorting.

Jumper Wire Termination Figures – Through-Hole Components

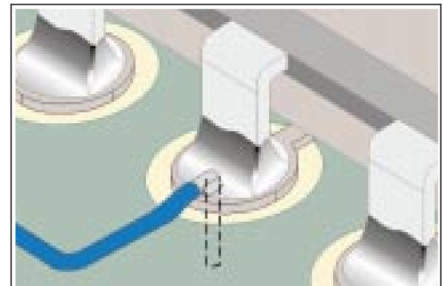

Figure 7 ***Acceptable*** Wire soldered into plated-through hole, component side. *

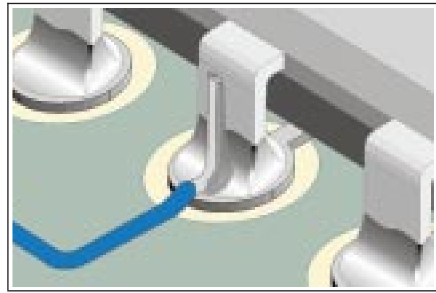

Figure 8 ***Acceptable*** Wire soldered parallel to lead on component side.

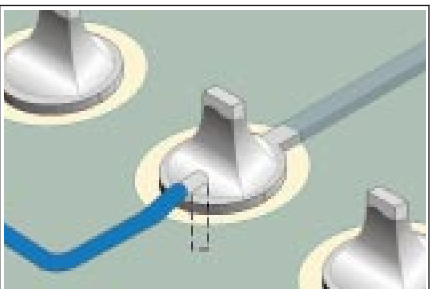

Figure 9 ***Acceptable*** Wire soldered into plated-through hole on solder side. *

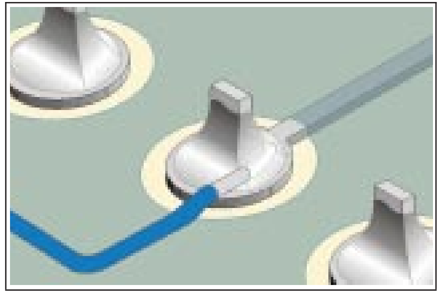

Figure 10 ***Acceptable*** Wire wrapped around component lead on solder side.

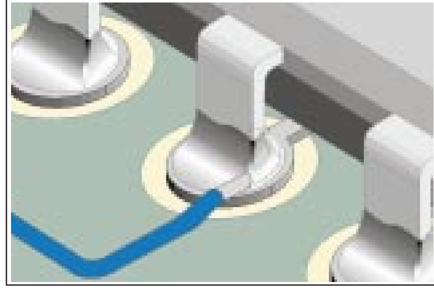

Figure 11 ***Acceptable*** Wire wrapped around lead on component side.

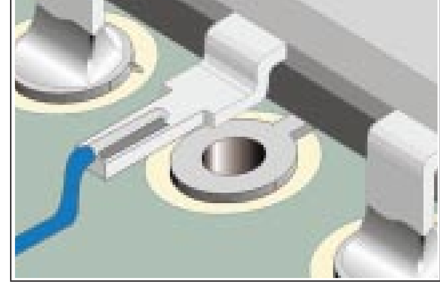

Figure 12 ***Acceptable*** Wire soldered to lifted component lead. +

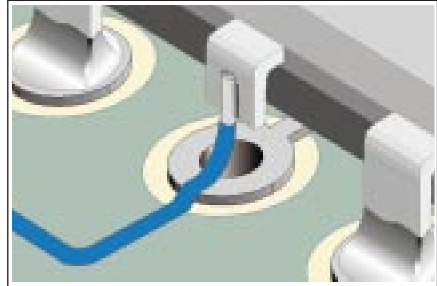

Figure 13 ***Acceptable*** Wire soldered to clipped lead on component side. +

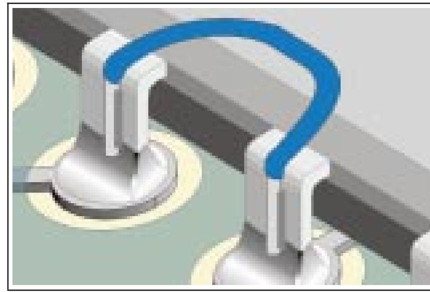

Figure 14 ***Acceptable*** Wire looped and soldered to adjacent component leads.

Figure 15 ***Not Recommended*** Wire soldered to lead, wire over component.

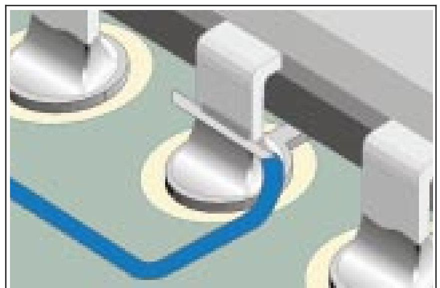

Figure 16 ***Not Recommended*** Soldered perpendicular to component lead.

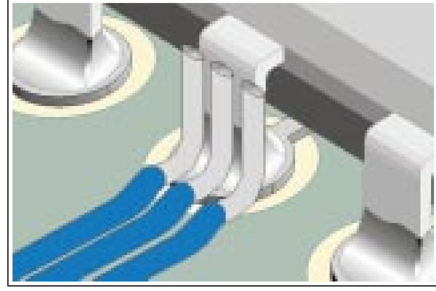

Figure 17 ***Not Recommended*** Multiple wires soldered to lead overhanging edge.

* Jumper wires soldered into plated-through holes must be discernible on the opposite side.

\+ Jumper wires soldered to lifted or clipped component leads may require insulation to prevent shorting.

Jumper Wire Termination Figures – Chip Components, Pads and Conductors

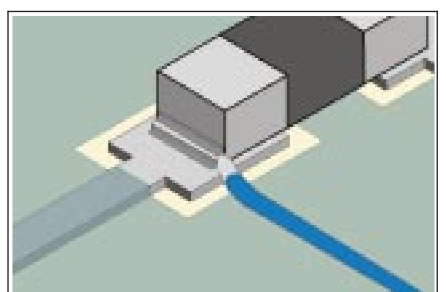

Figure 18 ***Acceptable*** Wire soldered to pad, parallel or perpendicular to component.

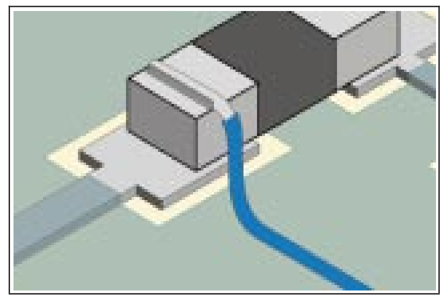

Figure 19 ***Acceptable*** Wire soldered parallel or perpendicular to component.

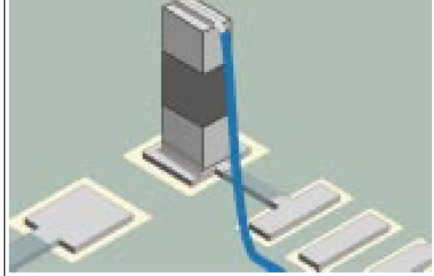

Figure 20 ***Acceptable*** Wire soldered to component end, lifted off pad.

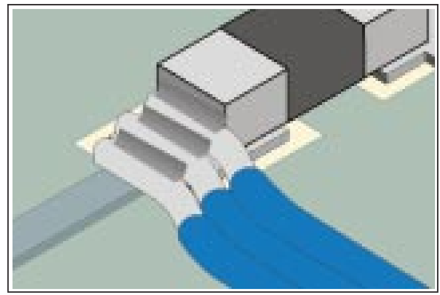

Figure 21 ***Not Recommmended*** Multiple wires overhanging pad edge.

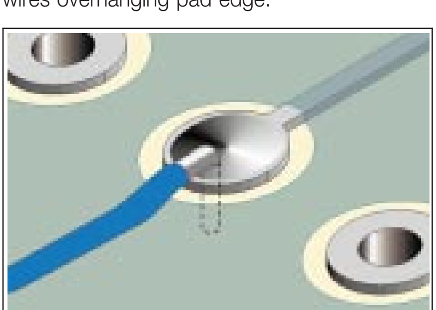

Figure 22 ***Acceptable*** Wire soldered into plated-through hole. *

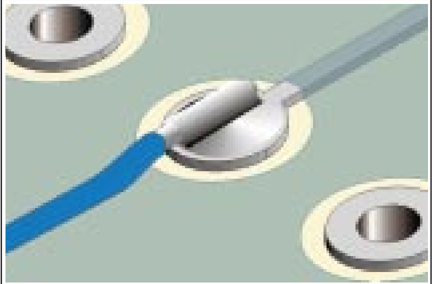

Figure 23 ***Acceptable*** Wire soldered across top of PTH pad.

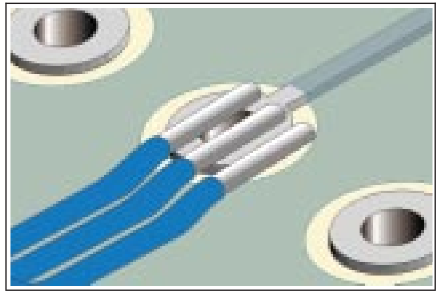

Figure 24 ***Not Recommended*** Multiple wires soldered to pad overhanging pad edge.

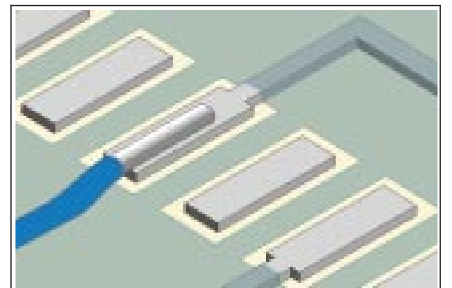

Figure 25 ***Acceptable*** Wire soldered parallel to conductor, contact, SMT pad.

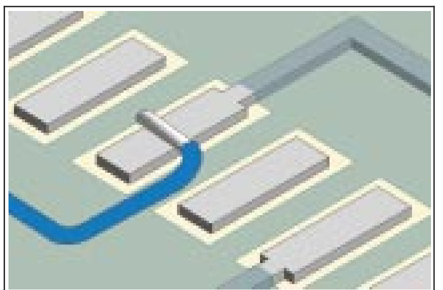

Figure 26 ***Not Recommended*** Wire perpendicular to conductor; contact, SMT pad.

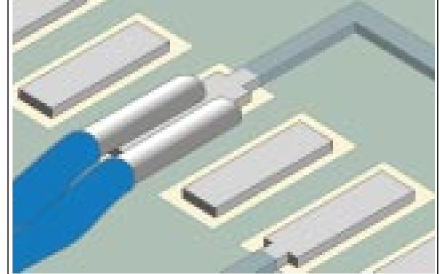

Figure 27 ***Not Recommended*** Multiple wires soldered to conductor, contact, SMT pad.

* Jumper wires soldered into plated-through holes must be discernible on the opposite side.
+ Jumper wires soldered to lifted or clipped component leads may require insulation to prevent shorting.

Jumper Wire Termination Figures – J Lead Components

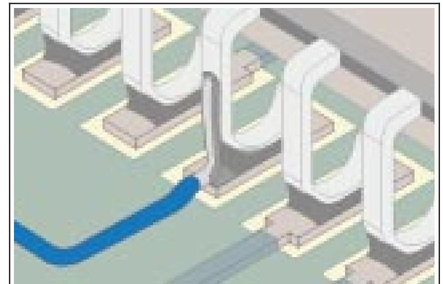

Figure 28 ***Acceptable*** Wire soldered parallel to component lead.

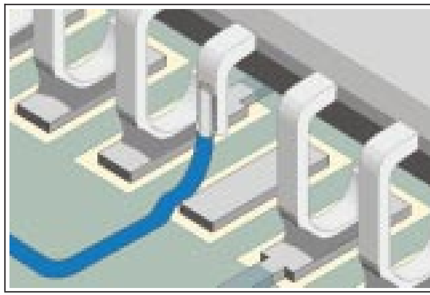

Figure 29 ***Acceptable*** Wire soldered to clipped component lead. +

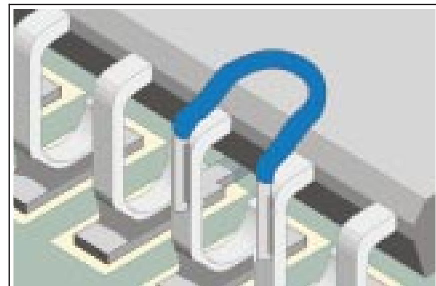

Figure 30 ***Acceptable*** Wire looped and soldered to adjacent leads.

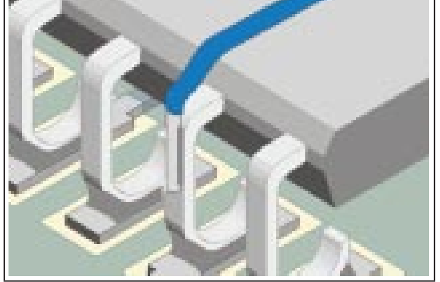

Figure 31 ***Not Recommended*** Wire soldered to lead, over component.

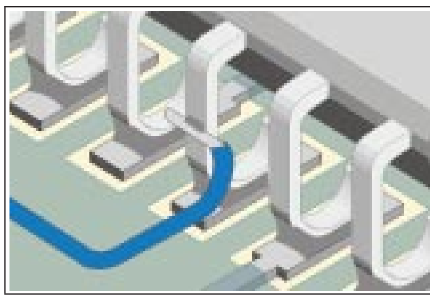

Figure 32 ***Not Recommended*** Wire soldered perpendicular to lead.

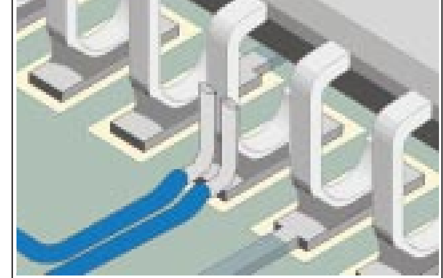

Figure 33 ***Not Recommended*** Multiple wires soldered to lead overhanging edge.

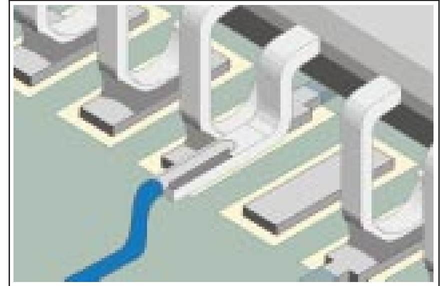

Figure 34 ***Not Recommended*** Wire soldered to lifted component lead.

* Jumper wires soldered into plated-through holes must be discernible on the opposite side.
+ Jumper wires soldered to lifted or clipped component leads may require insulation to prevent shorting.

Jumper Wire Termination Figures – Gull Wing Components

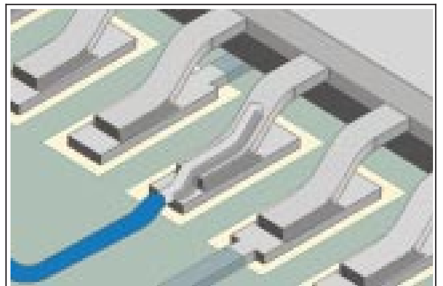

Figure 35 ***Acceptable*** Wire soldered parallel to component lead.

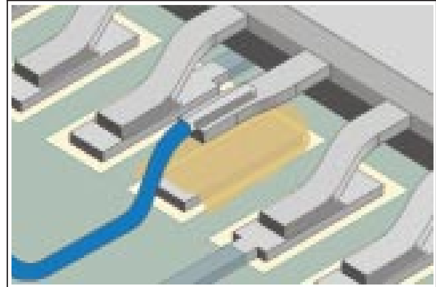

Figure 36 ***Acceptable*** Wire soldered to lifted component lead. +

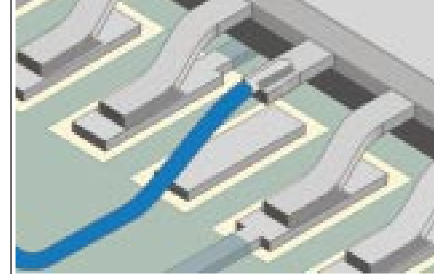

Figure 37 ***Acceptable*** Wire soldered to clipped component lead. +

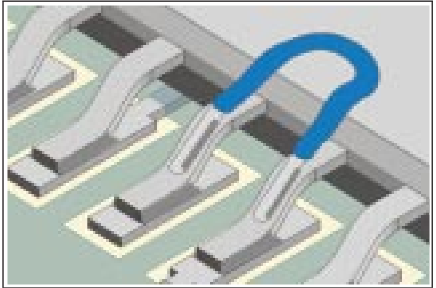

Figure 38 ***Acceptable*** Wire looped and soldered to adjacent component leads.

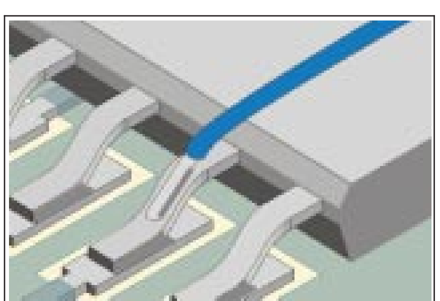

Figure 39 ***Not Recommended*** Wire soldered to component lead, wire over component.

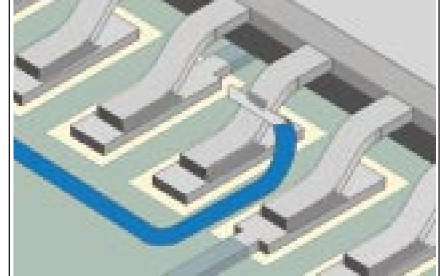

Figure 40 ***Not Recommended*** Wire soldered perpendicular to component lead.

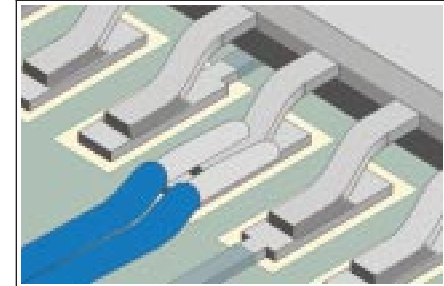

Figure 41 ***Not Recommended*** Multiple wires soldered to lead overhanging edge.

* Jumper wires soldered into plated-through holes must be discernible on the opposite side.
+ Jumper wires soldered to lifted or clipped component leads may require insulation to prevent shorting.

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7721

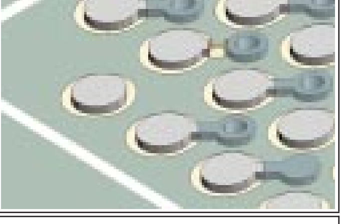
Repair and
Modification of
Printed Boards and
Electronic Assemblies

Revision:

Date: **11/99**

Number: **6.2.1**

Jumper Wires, BGA Components, Foil Jumper Method



Product Class: R/F
Skill Level: Expert
Level of Conformance: Medium

OUTLINE

This method is used to change a circuit path at a BGA site for engineering changes or modifications.

NOTE

This procedure requires precision milling equipment and highly trained technicians.

CAUTION

This procedure is not applicable for ‘‘via in pad’’ applications.

REFERENCES

1.0 Foreword
2.1 Handling Electronic Assemblies
2.2 Cleaning
2.5 Baking And Preheating
2.6 Epoxy Mixing and Handling
4.2.1 Conductor Repair, Foil Jumper, Epoxy Method
4.4.3 Surface Mount, BGA Pad Repair, Film Adhesive Method
6.1 Jumper Wires

TOOLS & MATERIALS

BGA Rework System
Bonding Iron
Bonding Tips
Bonding System
Buffer
Circuit Frames, BGA Pads
Cleaner
Drill System
End Mills
Epoxy
Flux, Liquid
Foil Jumpers
Heat Lamp
Microscope
Milling System
Oven
Precision Knife
Repair System or Repair Kit
Scraper
Solder
Soldering Iron
Tape, High Temperature
Tweezers
Wipes

PROCEDURE

1. Clean the area.
2. Remove the BGA component if installed, remove excess solder from the pads, and clean and inspect the site using standard BGA rework equipment.
3. Cut the short conductor (dog bone) connecting the BGA pad to the connecting via using a drill system or milling machine and appropriate size end mill. (See Figure 1 and 6.)
4. Remove the existing BGA pad. Apply heat from a soldering iron if needed. (See Figure 2.)

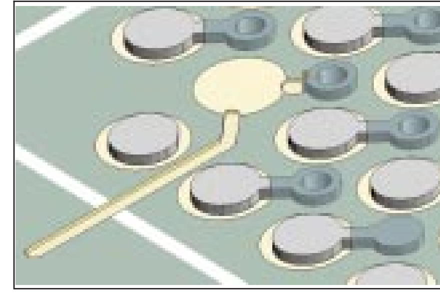


Figure 1 Cut the connection to the via using a drill system.

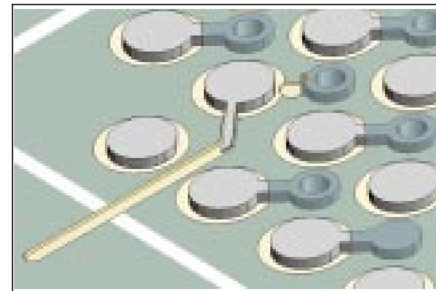


Figure 2 Remove BGA pad & mill shallow channel into solder mask surface.

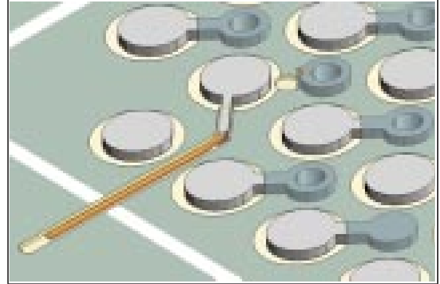


Figure 3 Bond a new BGA pad in place.

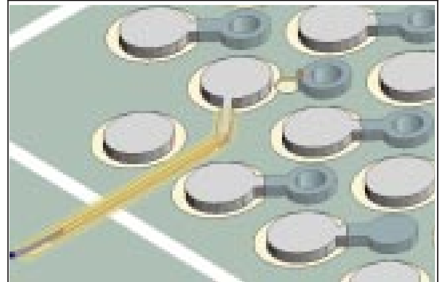


Figure 4 Solder a foil jumper to the tail extending from the new BGA pad.

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5. Inspect the proposed path for the foil jumper to ensure proper clearance. Use a milling machine to mill a shallow groove in the solder mask surface from the BGA pad area to the perimeter of the BGA site. Tight spacing may restrict the width of the channel to 0.25 mm [0.010 in] or less. Use a carbide end mill approximately 0.050 mm [0.002 in] wider than the new connecting circuit. (See Figure 3.)

   NOTE

   Be sure to mill a shallow groove to prevent damage to internal conductive layers.
6. Bond a replacement BGA pad in place using a bonding system. (See Procedure 4.7.3.) The new BGA pad must have a tail that will align with the foil jumper to be added next. (See Figure 4.)
7. Select a foil jumper to match the width and thickness of the circuit to be replaced. Cut a length approximately as needed. The foil jumper should overlap the BGA tail section a minimum of two times the circuit width.
8. Gently abrade the top and bottom ends of the new foil jumper with the buffer to remove any oxidation and clean.

   NOTE

   If needed, the ends of the foil jumper may be tinned with solder prior to lap soldering in place.
9. Position this new foil jumper along the milled groove. The foil jumper should overlap the existing circuit a minimum of two times the circuit width. (See Figure 4.)
10. Apply a small amount of liquid flux to the overlap joint.
11. Lap solder the foil jumper to the BGA tail section using solder and a soldering iron. Make sure the foil jumper is properly aligned.
12. Clean the area.
13. Mix epoxy. If desired, add color agent to the mixed epoxy to match the printed wiring board color.
14. Coat the top and bottom of the foil jumper with epoxy. The epoxy bonds the new circuit to the base board material and insulates the circuit. (See Figure 5.)

    CAUTION

    Some components may be sensitive to high temperature.
16. Clean the board as required.
17. Install new BGA per applicable procedures.
18. Solder one end of a fine gauge wire to the end of the extending foil jumper. (The opposite end of the wire will be soldered later.) (See Figure 5.)
19. Route and terminate the other end of the jumper wire.

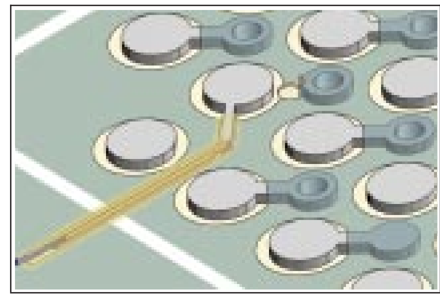

Figure 5 Solder a wire to the foil jumper bond with epoxy.

Figure 6 Sample of drill system used to cut the connection from the BGA pad to the via.

EVALUATION

1. Visual examination for alignment and overlap of new circuit.
2. Visual examination of epoxy coating for texture and color match.
3. Electrical tests as applicable.

2215 Sanders Road
Northbrook, Illinois
60062-6135

Tel 847 509.9700
Fax 847 509.9798
URL: http://www.ipc.org

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